Net Impact of Spruce Beetle Outbreak on White River National Forest, 1939-1951

Donn B. Cahill

Cahill

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

F&AO

REPLY TO: 5100 Fire Control
(4500)

December 21, 1972

SUBJECT: Spruce-Beetle Impact Study

RECEIVED
DEC 21 1972
Timber Management

TO: Division Chief, TM
Attn: Donn Cahill

As discussed with you, we think the fuels information you gathered during the Spruce-Beetle Impact Study does have applicability to Fire Management.

The study gives us:

1. A reliable estimate of tons per acre and size of heavy dead fuels on the ground.

2. Number, size and tons per acre of snags.

Both of the above are important when calculating the resistance to control of fires. The snags also contribute to the rate of spread when spotting occurs.

The number of snags per acre is also a safety factor, and should be considered before putting men into areas of high snag concentrations.

The White River National Forest can use the information for their hazardous fuels area inventory, and also pre-attack plans.

J. L. Sanderson

for J. L. SANDERSON
Assistant Regional Forester

15.521
c.2

R2 - TM

5200 Forest Insect and Disease Control September 24, 1973

Spruce Beetle Impact Study

Chief

We are enclosing our preliminary report on the spruce beetle impact study on the White River National Forest. The spruce beetle outbreak occurred shortly after a windstorm in 1939 and subsided in 1951 due to extremely cold winter temperatures. The surviving beetle population was chemically controlled in 1952. + Cooloides + chem control (w=M)

Limited investigation is presently being conducted in the study area and the final report should be completed this winter.

Frank J. Kopecky

FRANK J. KOPECKY
Acting Assistant Regional Forester

Enclosure

cc: R-3
INT (Cole)
RM (Stevens)
White River NF

PRELIMINARY REPORT

NET IMPACT OF SPRUCE BEETLE OUTBREAK ON WHITE RIVER NATIONAL FOREST, 1939-1951

Donn B. Cahill

Introduction

In the winter of 1972, the Washington Office of Forest Pest Control, U.S. Forest Service, made assignments to each Regional and Area Office to collect and report the net impact of specific insects and diseases. The spruce beetle was assigned to Region 2 and D. B. Cahill was selected to coordinate the effort on determining net impact from the insect. Since it would be too time-consuming to attempt to collect this information from throughout the entire Region, it was decided to concentrate on one area--the Buck Creek and Dry Buck drainages on the White River National Forest (see map). This area is part of a 670,000-acre area that was devastated by an epidemic of the spruce beetle in Engelmann spruce between 1939 and 1951. The epidemic started from a buildup of the beetles in trees which were windthrown in 1939. The end of the epidemic coincided with extremely low winter temperatures in 1951.

Survey Methods

A determination of net impact involves the many uses that are in one way or another affected by the dying of spruce trees from the bark beetle epidemic. This problem was discussed with representatives of the several resource divisions in the Forest Service Regional Office in Denver. As a result of these discussions, Forest Pest Control arranged to have Region 2 Forest Survey teams obtain Stage 2 sampling data from the 5,000-acre Buck Creek Study Area. The standard Stage 2 inventory data were augmented by the collection of additional data on range and browse plants and for fire rating assessment. Separate analyses were made by Forest Service soils, water, wildlife, and recreation specialists.

Forest Survey sampling consisted of four major steps:

1. Range plant density.--This step was taken first to avoid trampling of ground vegetation. From the plot center, 25-foot transects were taken in each cardinal direction. At each foot along the transects, a 3/4-inch range loop was placed on the ground (Photo 1). A total of 100 points was sampled at each plot. Within each range loop all vegetation was identified, at least as to genus. Photos 2 and 3 show two of the plants which are common in this area.

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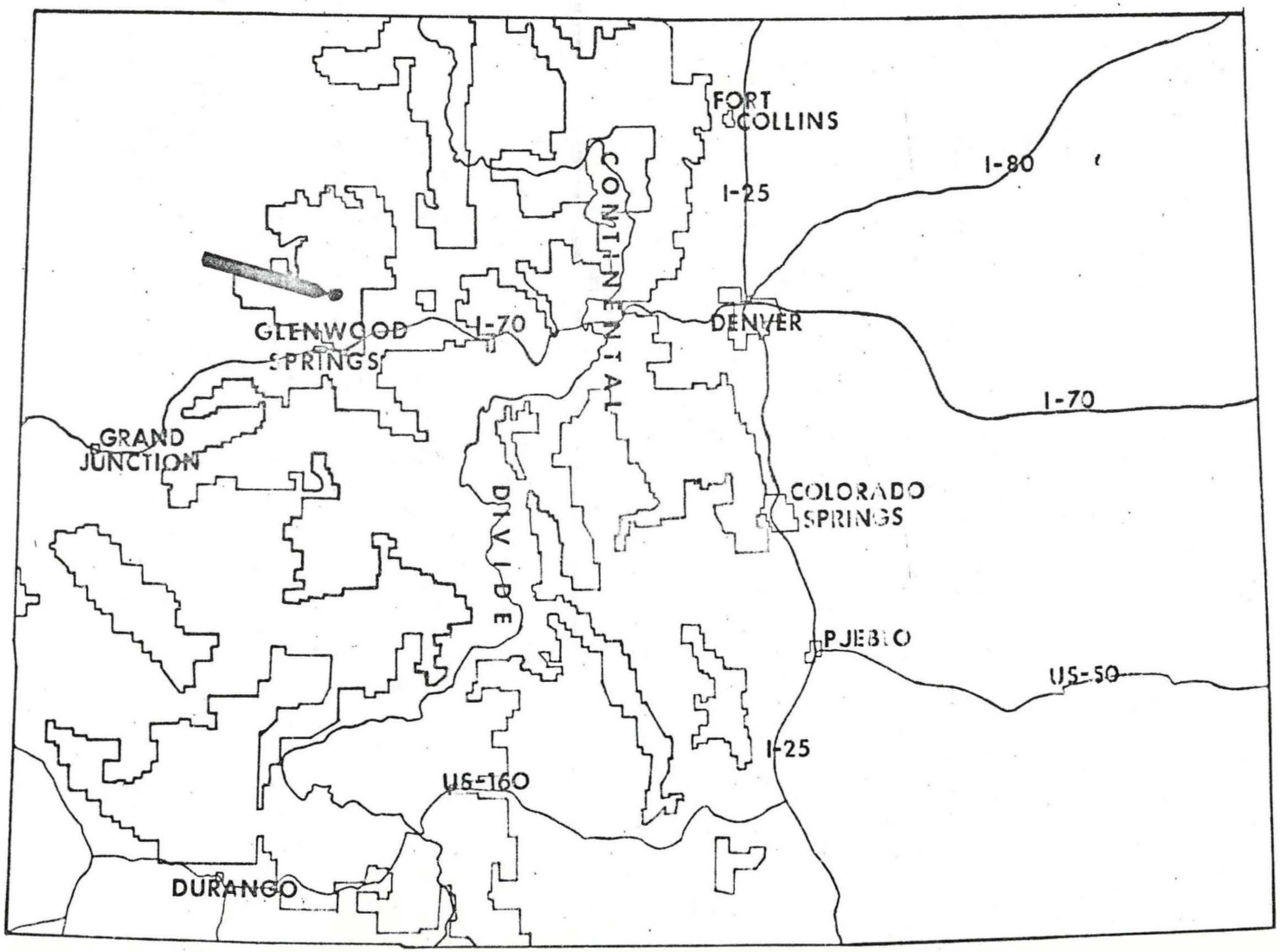
Grey area shows general extent of 1939-1951 spruce beetle outbreak. Arrow points to the impact study area.



STATE OF COLORADO

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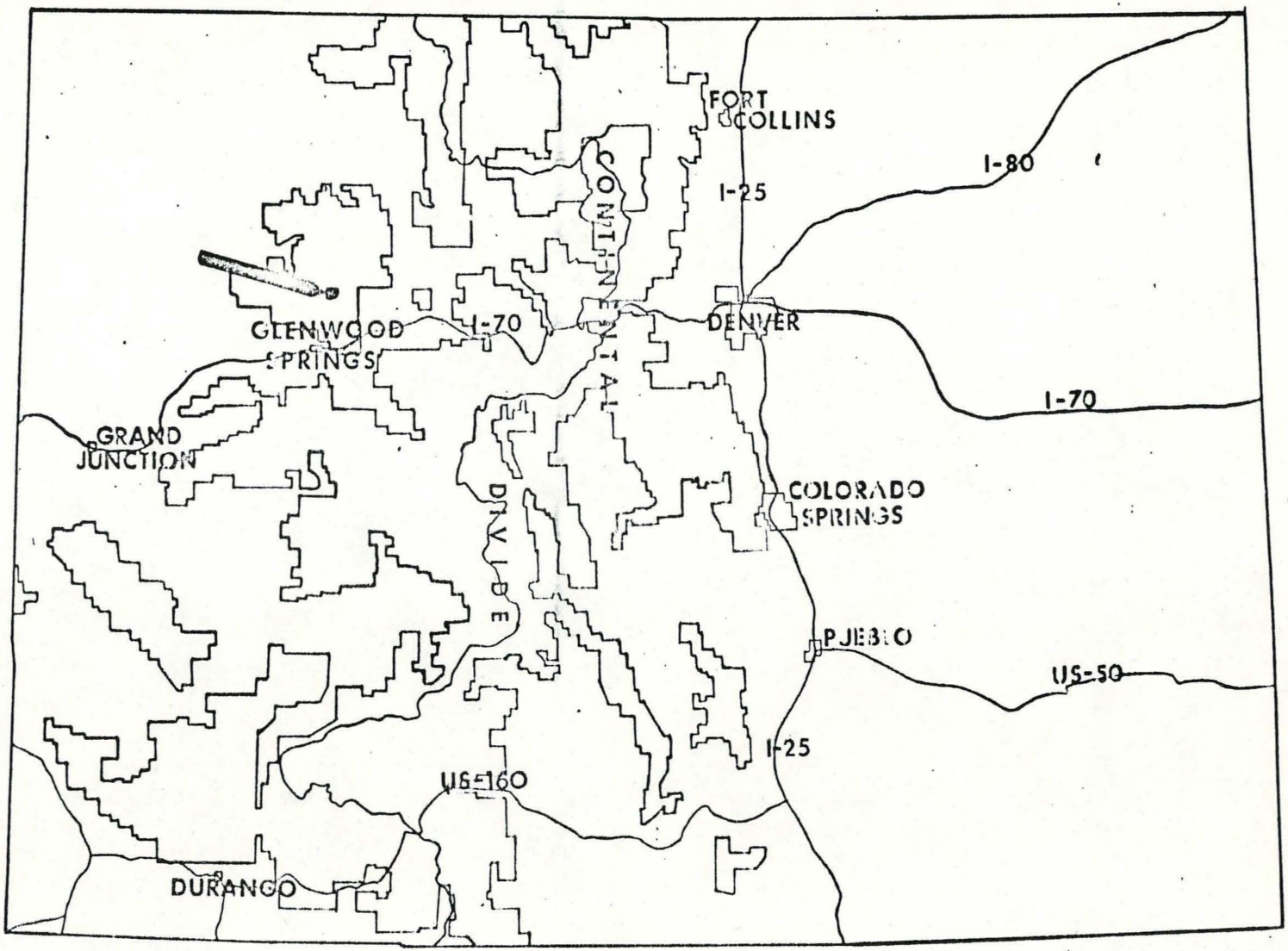

STATE OF COLORADO

Photo 1.--Measuring range plant density with 3/4-inch loop on a 25-foot transect.

Colorado Columbine (*Aquilegia coerulea*)

Indian Paintbrush (*Castilleja* sp.)

Photos 2 and 3.--Examples of vegetation in stand opening created by beetle-killed spruce on White River National Forest.

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Photo 4.--The dark green timber between dead spruce patch and rocky open ridge is the control area referred to in this study.

Impact Analysis

It was felt that the most effective way to arrive at net impact was to collect impact information and work this in with resource values. Therefore, an attempt was made to have resource specialists determine these values. Where values were not determined by a specialist, arbitrary values were assigned, hoping at a later date to gain input from resource specialists. In some cases, resource values are shown in dollars, and in others only in ± values. Dollars can have different values over time for a given resource; therefore, today's dollar values were used and in some examples projected to show future economic values.

Timber

The Engelmann spruce stand in which the 1941-1952 outbreak occurred would be classified as mature and overmature. Therefore, this study shows the probable maximum impact that spruce beetle could have on any stand (Figure 1). If a spruce stand were in a management program, the losses should never be this high.

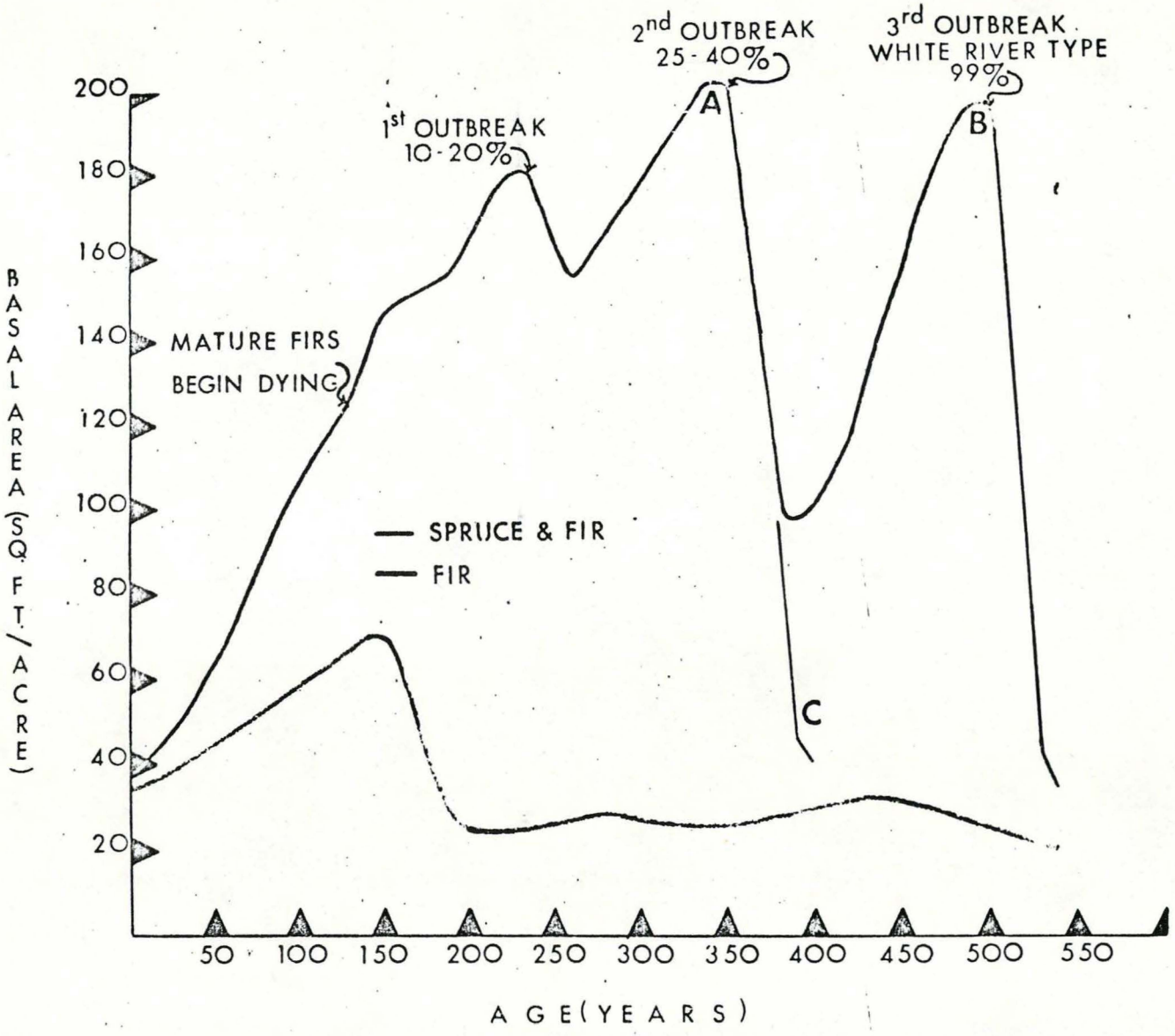
However, this situation is developing in our unmanaged spruce stands. Within the study area, it was estimated that by 1952, 3 billion board feet of spruce timber on 670,000 acres had been destroyed. Using present day value of stumpage, this would amount to a loss of about $120,000,000. In terms of retail value--if you were buying lumber to remodel your house, for example--it would be about $1,080,000,000. The loss could also be expressed as the lumber needed to build 200,000 modern 3-bedroom homes.

Stand composition by basal area (BA).--The BA of the control stand is comprised of 80% spruce and 20% fir. This stand represents the approximate species composition of the entire area prior to the spruce beetle epidemic. By contrast, all of the stands sampled within the study area are now primarily fir (see Figure 2). Following the epidemic, some of the areas were logged to salvage the dead spruce. These areas have also come back to fir. Basal areas within the study area ranged from 130 for one stand with large, well-crowned fir (classed as a spruce-fir sawtimber stand) to BA's of about 30 to 50 for the other eight spruce-fir stands. The BA of the cutover areas averages less than 10.

Cubic foot volumes.--It is estimated that stands averaged 6,000 cu. ft. per acre prior to the epidemic (see Figure 3a). Stand types sampled on the study area averaged less than 1,000 cu. ft. per acre, with the largest sawtimber stand having about 2,000 cu. ft. per acre. The control area averaged 2,000 cu. ft. per acre; however, this stand is much younger than the stand that was attacked by the beetles. No mature stands typical of those existing prior to the epidemic survived.

FIGURE 1

Developed from Schmid and Hinds' table showing what might happen to a spruce-fir stand over several centuries.[1]



[1]J. M. Schmid and T. E. Hinds. Spruce-fir stands following spruce beetle outbreaks. (In press revision)

STAND COMPOSITION BY BASAL AREA

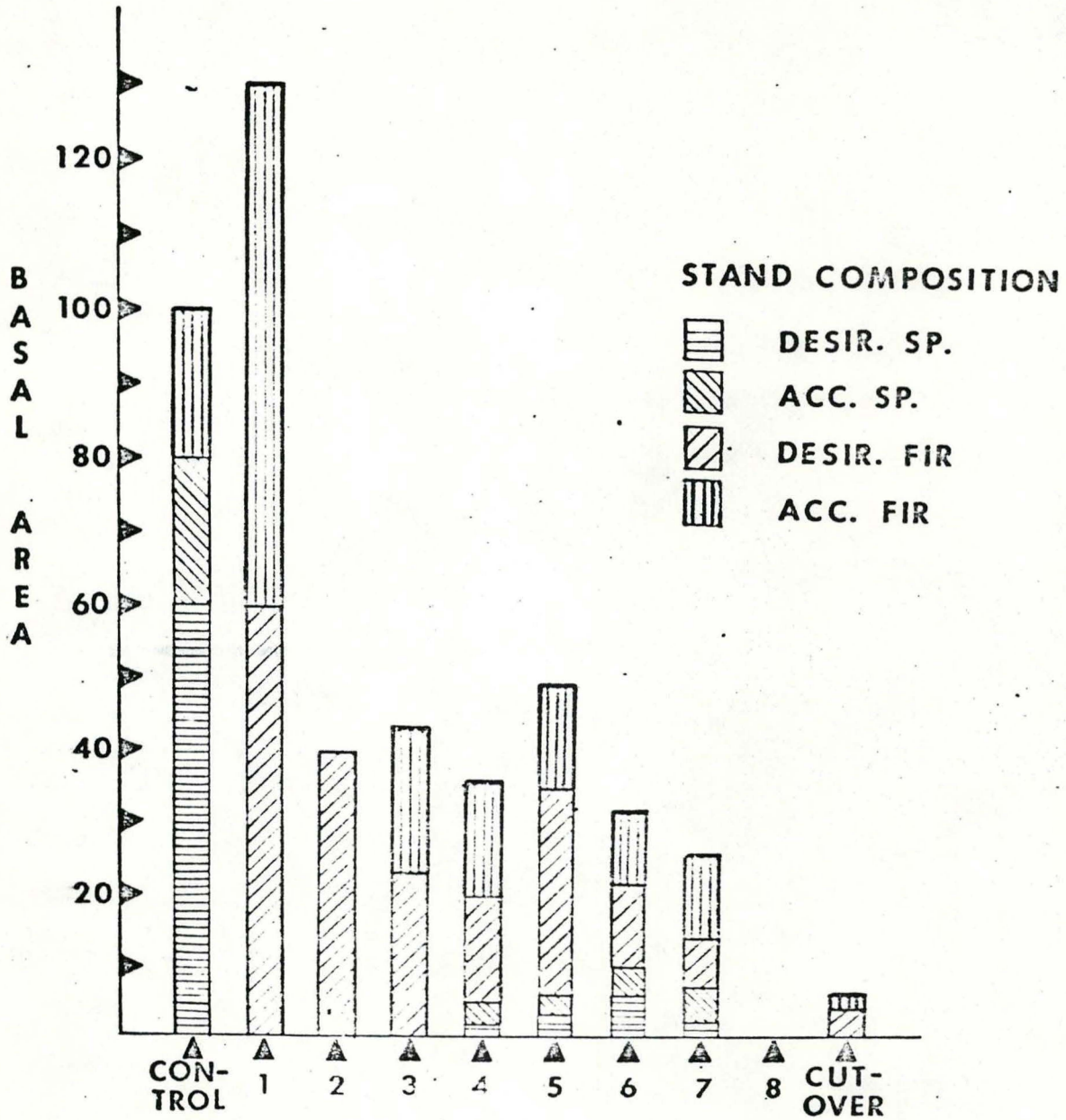


FIGURE 2

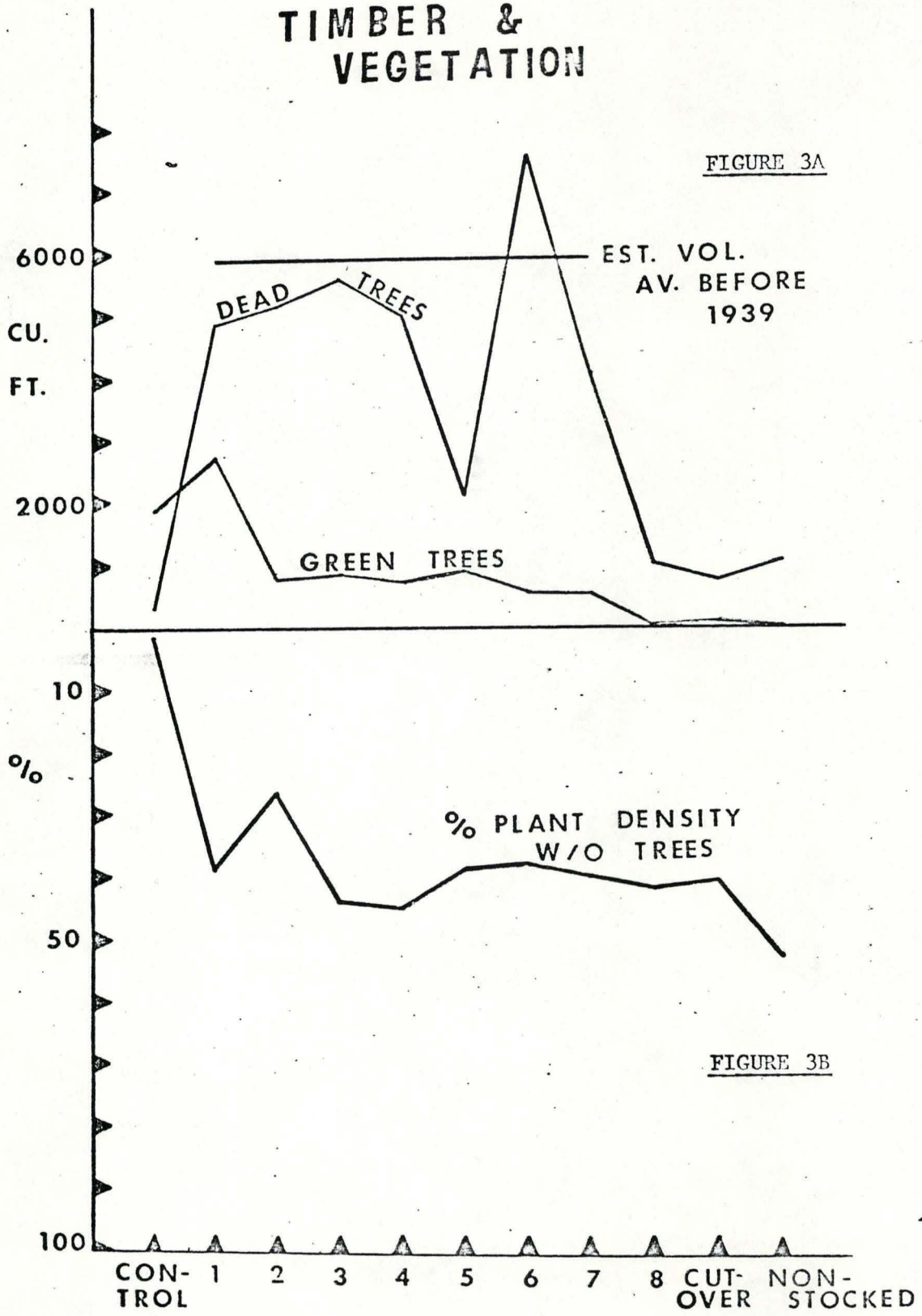


FIGURE 3A

FIGURE 3B

Vegetation by stand types.--The percentage of ground area covered by all vegetation, other than trees, increased dramatically in all study area stand types as compared to the control stand (Figure 3b). The control stand had almost no vegetative cover, whereas all stand types within the study area had between 25 and 40 percent of the ground area covered by vegetation.

The amount of vegetative cover is important in considering animal population levels between old-growth stands and the stands that have developed following the beetle epidemic.

Water

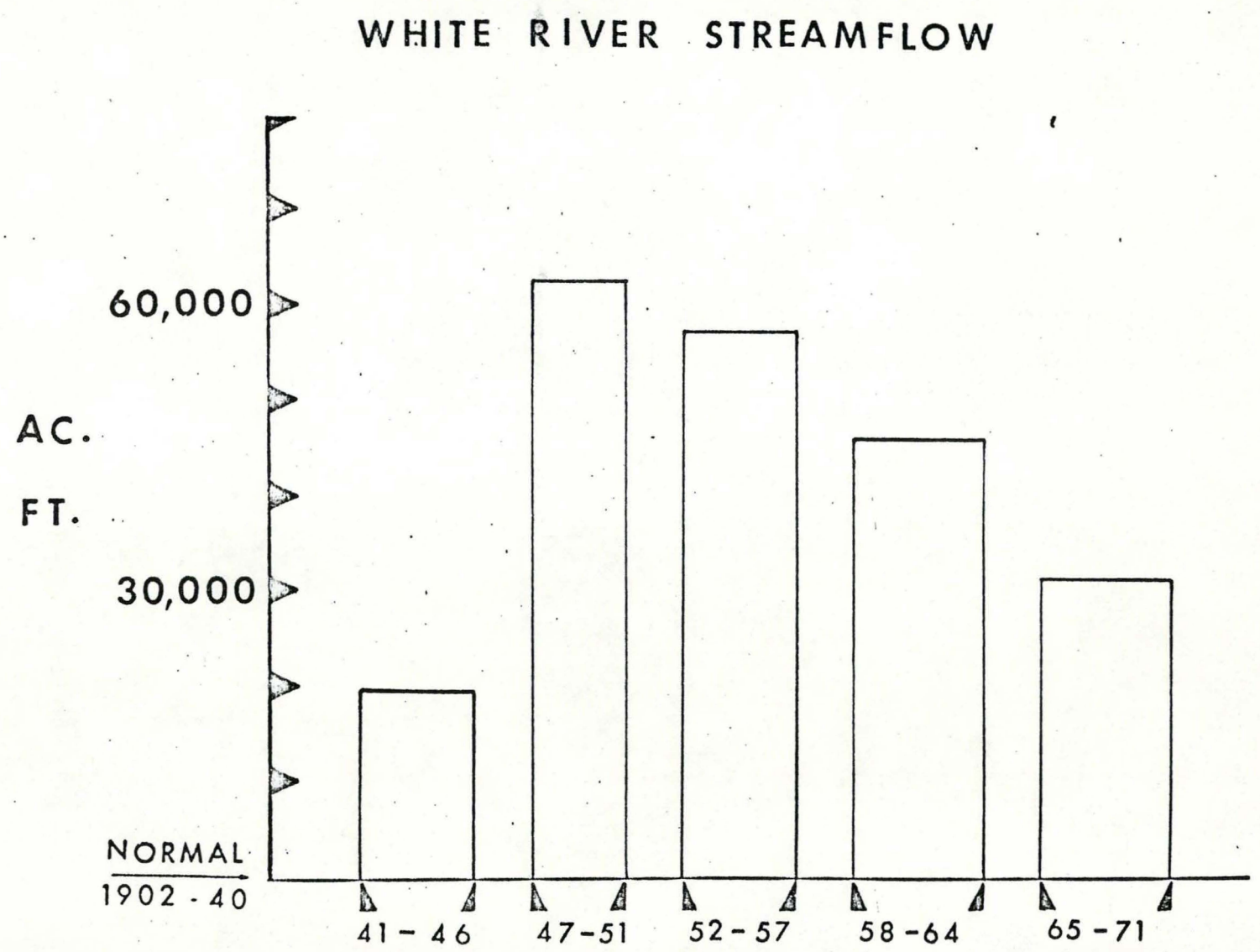
Water yield has benefited from the spruce beetle outbreak, and these benefits will probably continue up to about 50 years from the time the outbreak began. However, this beneficial yield has been decreasing since the outbreak ended (Figure 4) and by about 1990 the White River streamflow will probably return to the 1902-1939 "normal." The White River drainage is only one of four major river drainages which make up the headwaters of the Colorado River, and all were affected by the 1939-1951 spruce beetle outbreak. The Colorado River is the major source of water for most of the Southwest, from the west side of the Rockies to Los Angeles. Some water from the upper drainage has even been diverted to the east side of the Rockies.

The White River drainage has sustained an increased water yield of 218,276 acre feet since the outbreak began in 1941. The Colorado River water values were $5/ac. ft. during the early years of this additional water yield, but some of the present value estimations consider it to be worth $16/ac. ft. Therefore, dollar value of increased yield may be figured: 218,276 @ $5/ac. ft. = $1,091,380; or 218,276 @ $16/ac. ft. = $3,492,416. However, a more realistic dollar value may be $1,438,727, as shown by the following tabulation:

Time period	Acre feet	$/acre	Total value
1941-1964	186,699	$ 5	$ 933,495
1965-1971	31,577	16	505,232
	218,276		$1,438,727

One important consideration in the discussion of water yield is that much water development planning has been done that includes the increased yield created by the spruce beetle outbreak; however, for all practical purposes, this is a temporary situation which may well end by 1990. This becomes more important because present plans call for about half of the White River drainage to be designated as wilderness. On these lands, no stand management will be allowed. Also, there is no present management

FIGURE 4.--Increased streamflow during outbreak buildup (1941-46) and epidemic (1947-51), and gradual decrease following outbreak as ground vegetation returns.



method (excluding cloud seeding) which can maintain the annual increase of 6,000 acre feet of water on the half of the land that is available outside of wilderness lands since the timber stand will not fully recover from the effects of the beetle outbreak for many more years.

Wildlife

Animal population changes over time were reconstructed by consulting with wildlife specialists. These specialists made observations in the area and used the vegetative data collected on both the control area and the study area as a basis for their estimates (Figure 5).

Spruce beetle populations increased rapidly following the 1939 blowdown, reaching a peak in the middle and late 1940's, and then crashing to low levels in 1951. The beetle populations have remained low throughout the study area since that time. These beetle populations had an effect primarily on woodpeckers and small mammals which increased in numbers with the increase in bark beetles. Woodpeckers followed the increase and decline curve of beetle numbers with a more gradual increase at the onset of the epidemic and a decline that was not as drastic as that of the beetles because of secondary insects in the wood. Small mammal numbers increased gradually with the beginning of the epidemic, reached but moderate levels during the epidemic, declined with the end of the epidemic, and have maintained population levels that were about the same as those prior to 1939.

Elk, deer, blue grouse, and large animal predators all increased during the latter stages of the beetle epidemic due primarily to vegetative changes. These animal populations continued a gradual increase for many years with the elk, deer, and grouse populations declining slightly in the last 5 to 10 years. Large animal predators have continued a slight increase to the present time, but may have reached a peak.

Fire

In looking at the spruce beetle impact on the fire situation, we find that it is not too important for about 360 days out of the year. However, for 2 to 8 days of the year, the problem may become very important in protecting the forested environment.

Figure 6 shows that over 40 percent of the forested land in the sample area has 55 or more tons per acre of dead material. Figure 7 shows that 97 percent of the forested area has at least 55 snags/acre and 20 percent of the forested area has 120 snags/acre. In thinking about snags per acre and the tons of dead material, and adding the number of stems of young trees, along with a few days of extreme fire danger

FIGURE 5

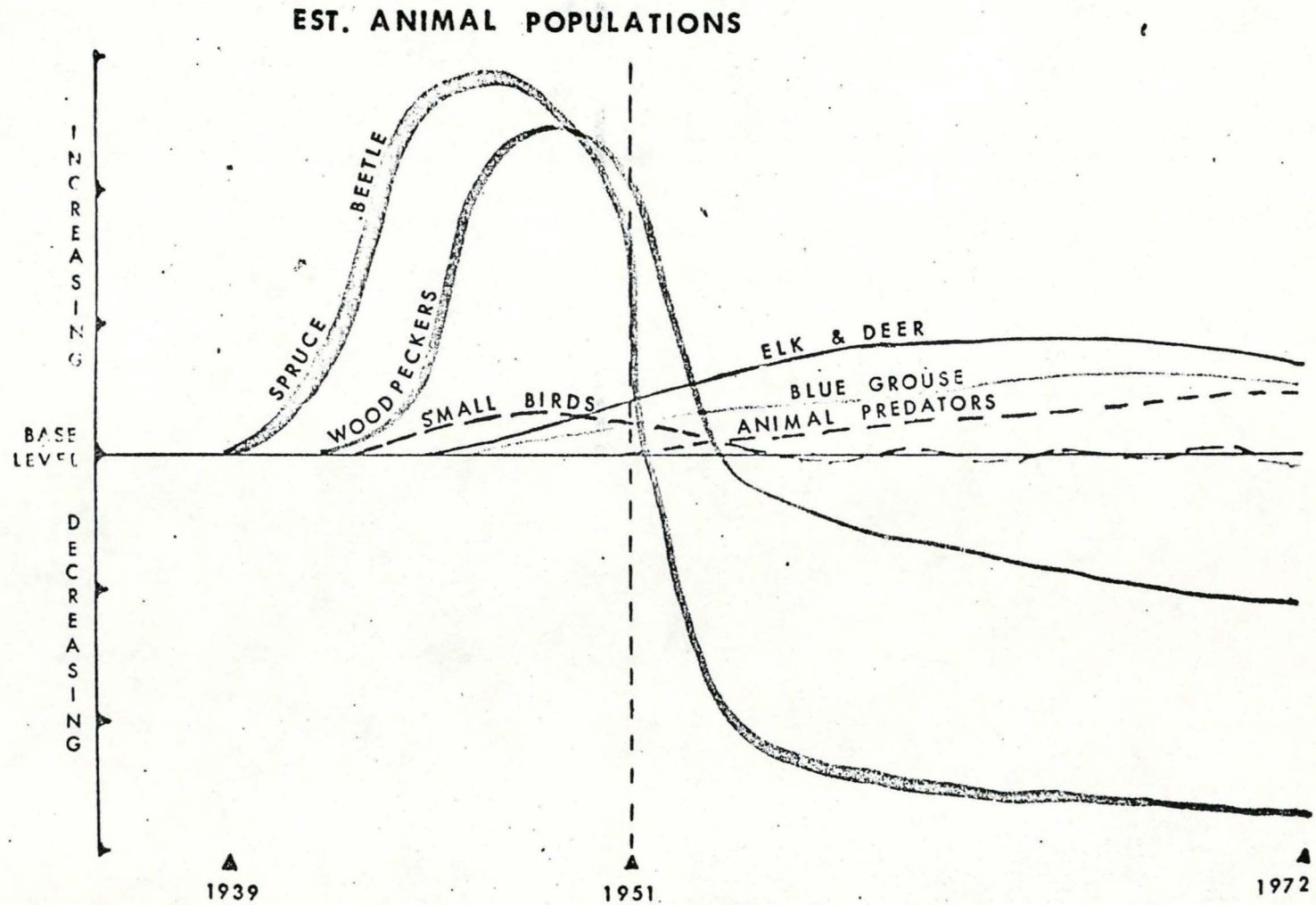
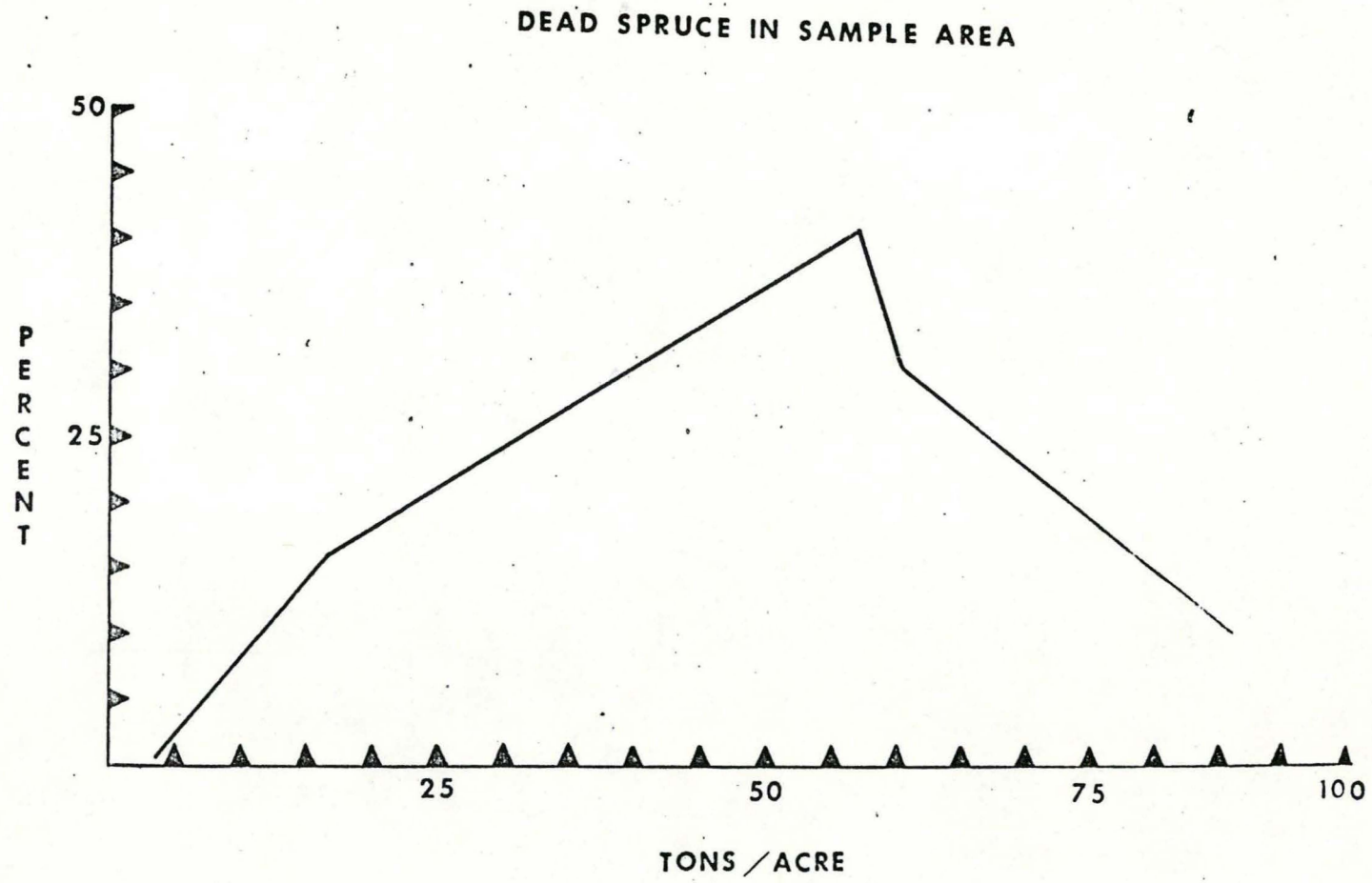
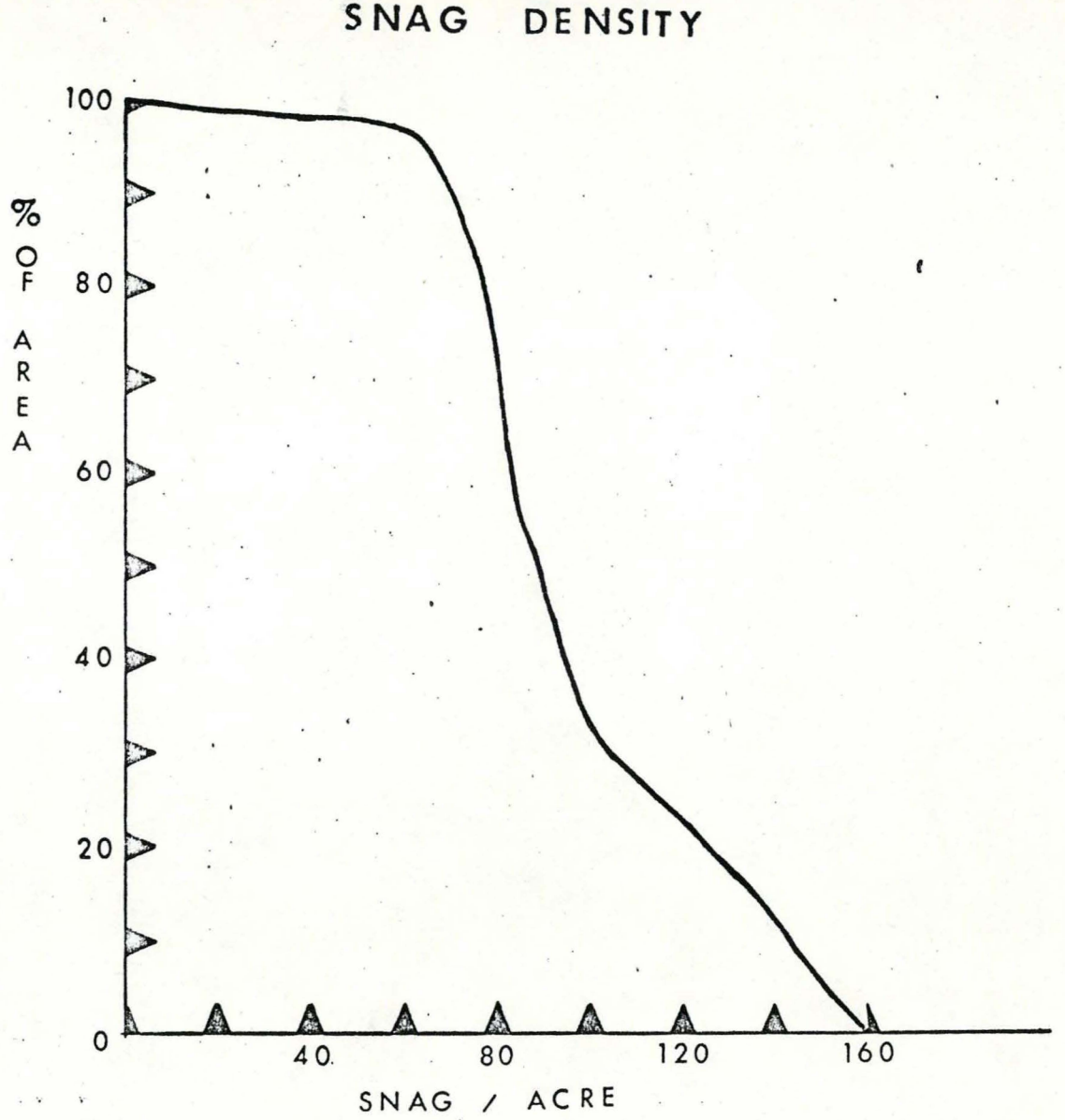

EST. ANIMAL POPULATIONS
INCREASING
BASE LEVEL
DECREASING
SPRUCE BEETLE
WOODPECKERS
SMALL BIRDS
ELK & DEER
BLUE GROUSE
ANIMAL PREDATORS
1939
1951
1972

FIGURE 6


DEAD SPRUCE IN SAMPLE AREA
50
25
PERCENT
25
50
75
100
TONS / ACRE


SNAG DENSITY
100
80
60
40
20
0
% OF AREA
40
80
120
160
SNAG / ACRE

rating, we come up with a fire situation that may be difficult to control. In most cases, snag density per acre creates an unsafe situation for the individual firefighter. The risk factor would have to be determined for each stand and resource to be protected.

Man's Maneuverability

What effect has the spruce beetle outbreak had on man's foot travel in forested areas? Man likes to hunt, fish, and backpack into undeveloped areas. Photos 5 and 6 show two similar hillsides. Photo 5 was taken near Deep Lake, and shows a picnic area next to the lake and a campground on a bench above and to the left of the picnic ground. The campground was logged about the time the epidemic was at its peak. Photo 6 was taken on Buck Creek; the area has a similar profile but was not logged. In comparing these two photos, it is easy to see the hazards from snags if the campground had not been logged.

Photo 5.--Deep Lake

Photo 6.--Buck Creek

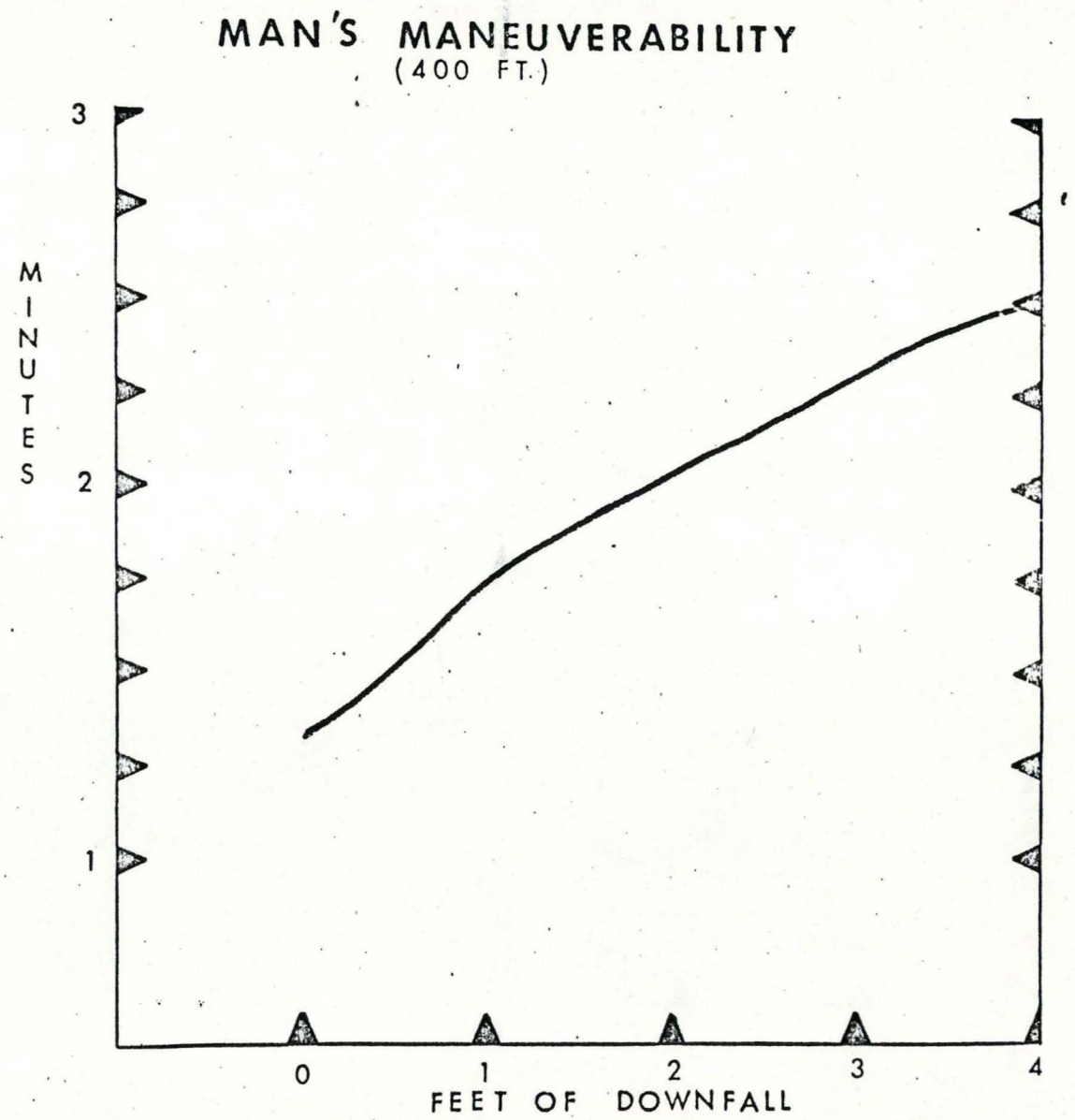
In the study area, stand surveys showed that 41 percent of spruce beetle snags have fallen, of which 28 percent have sap rot. In some areas the down snags have reached a depth of 4 feet per acre. This makes foot travel difficult for both man and big game. Figure 8 shows time studies which were made to determine the difficulty of foot travel at this elevation for a man of average height in fairly good physical condition. It takes twice the time to cover the same distance with 4 feet of down material than when the ground is free of debris. Another hazard to consider in walking in some of these snag patches is that about 2.8 percent of these dead trees fall per year. This hazard increases when there are strong winds and wet soils.

It is estimated that about 20 snags per year will fall across one mile of trail, whereas in most spruce country where spruce beetles have not created a snag problem it would be about 4 or 5 snags per year per mile. Thus the cost of trail maintenance has increased four or five times. As a result, in most spruce beetle snag areas in the White River National Forest, trails have not been cleared (Photos 7 and 8). These snag patches are an added hazard to individuals using these trails. Posting an area is one method used to warn the public of this hazard.

Photo 7.--Standing and down snags along side of an old trail.

Photo 8.--Fallen snags are a continuing problem in trail maintenance in spruce beetle-killed timber on White River National Forest.

FIGURE 8


MAN'S MANEUVERABILITY
(400 FT.)
MINUTES
3
2
1
0
1
2
3
4
FEET OF DOWNFALL

APPENDIX

Photo 9.--One of the heavy snag patches, showing young reproduction. This stand would be classed DS½Minus.

STAND SURVEY INDEX

The timber stand was subdivided into photo interpretation strata as follows:

Stand no.*	Timber type
1	SF9AWM
2	SF9AWP
3	SF9AMM
4	SF9AMP
5	SF9APP
6	DS½Plus
7	DS½Minus
8	SF8P

*As shown in preliminary report figures.

Explanation of Symbols

SF9AWM
SF = spruce-fir timber type. In this case, most spruce was killed by bark beetles during outbreak.

SF9AWM
9+A = large sawlogs
8 = pole-size trees

SF9AWM
W = well developed crowns
M = medium developed crowns
P = poorly developed crowns

FS9AWM
W = well stocked reproduction
M = medium stocked reproduction
P = poorly stocked reproduction

DS½Plus = all mature spruce are dead; more than one-half of remaining stand composed of green trees (primarily fir).

DS½Minus = all mature spruce are dead; less than one-half of remaining stand composed of green trees.

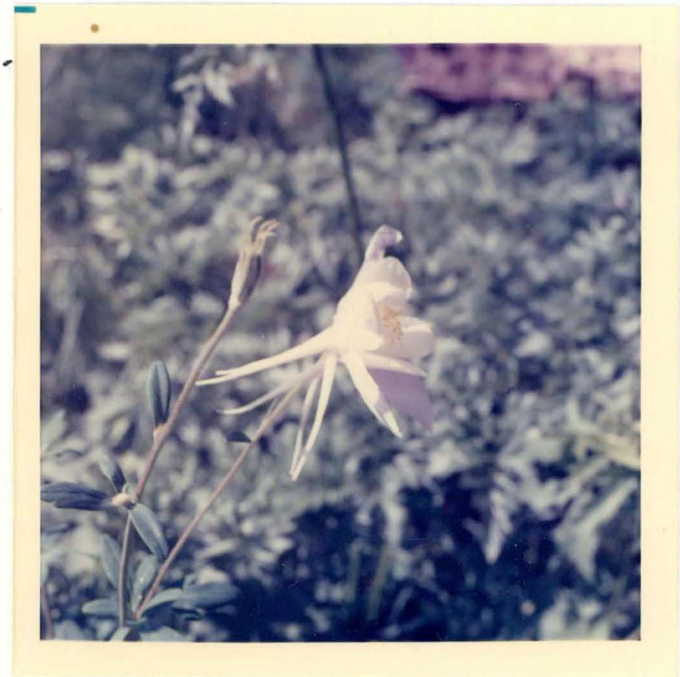
*Mountain Bluebird (*Sialia currucoides*)
*Robin (*Turdus migratorius*)
*Townsend's Solitaire (*Myadestes townsendi*)
*Hermit Thrush (*Hylocichla guttata*)
Golden-crowned Kinglet (*Regulus satrapa*)
*Ruby-crowned Kinglet (*Regulus calendula*)
*Audubon's Warbler (*Dendroica auduboni*)
*Wilson's Warbler (*Wilsonia pusilla*)
*Western Tanager (*Piranga ludoviciana*)
Evening Grosbeak (*Hesperiphona vespertina*)
*Cassin's Finch (*Carpodacus cassinii*)
*Pine Grosbeak (*Pinicola enucleator*)
Red Crossbill (*Loxia curvirostra*)
White-winged Crossbill (*Loxia leucoptera*)
White-winged Junco (*Junco aikeni*)
*Slate-colored Junco (*Junco hyemalis*)
Oregon Junco (*Junco oreganus*)
*Gray-headed Junco (*Junco caniceps*)
Chipping Sparrow (*Spizella passerina*)
*White-crowned Sparrow (*Zonotrichia leucophrys*)
White-throated Sparrow (*Zonotrichia albicollis*)
Fox Sparrow (*Passerella iliaca*)
*Pine Siskin (*Spinus pinus*)
Violet-green Swallow (*Tachycineta thalassina*)

APPENDIX IV

ANALYSIS OF EFFECTS ON RECREATION

Photo 1.--Measuring range plant density with 3/4-inch loop on a 25-foot transect.

Colorado Columbine (Aquilegia coerulea)



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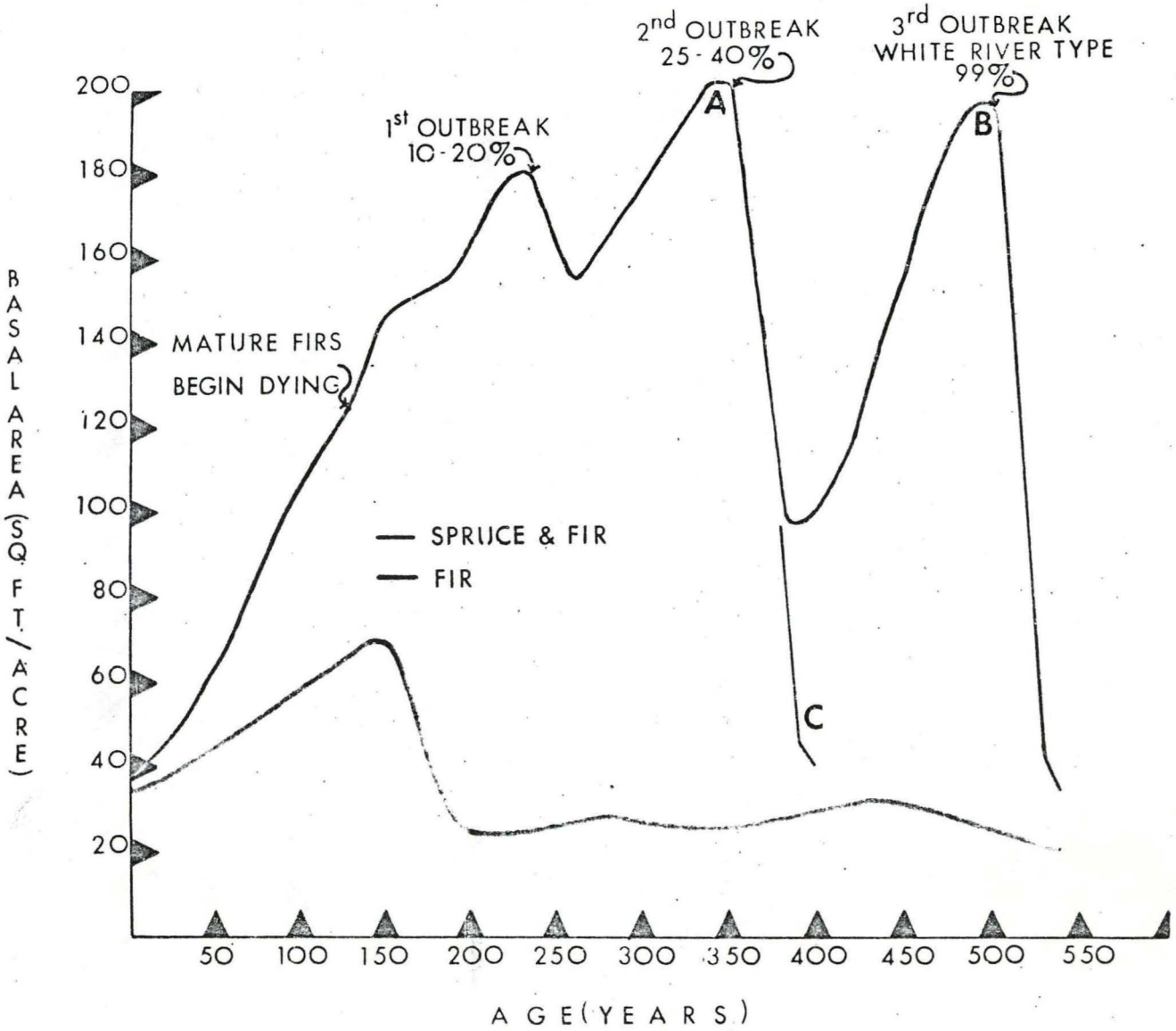

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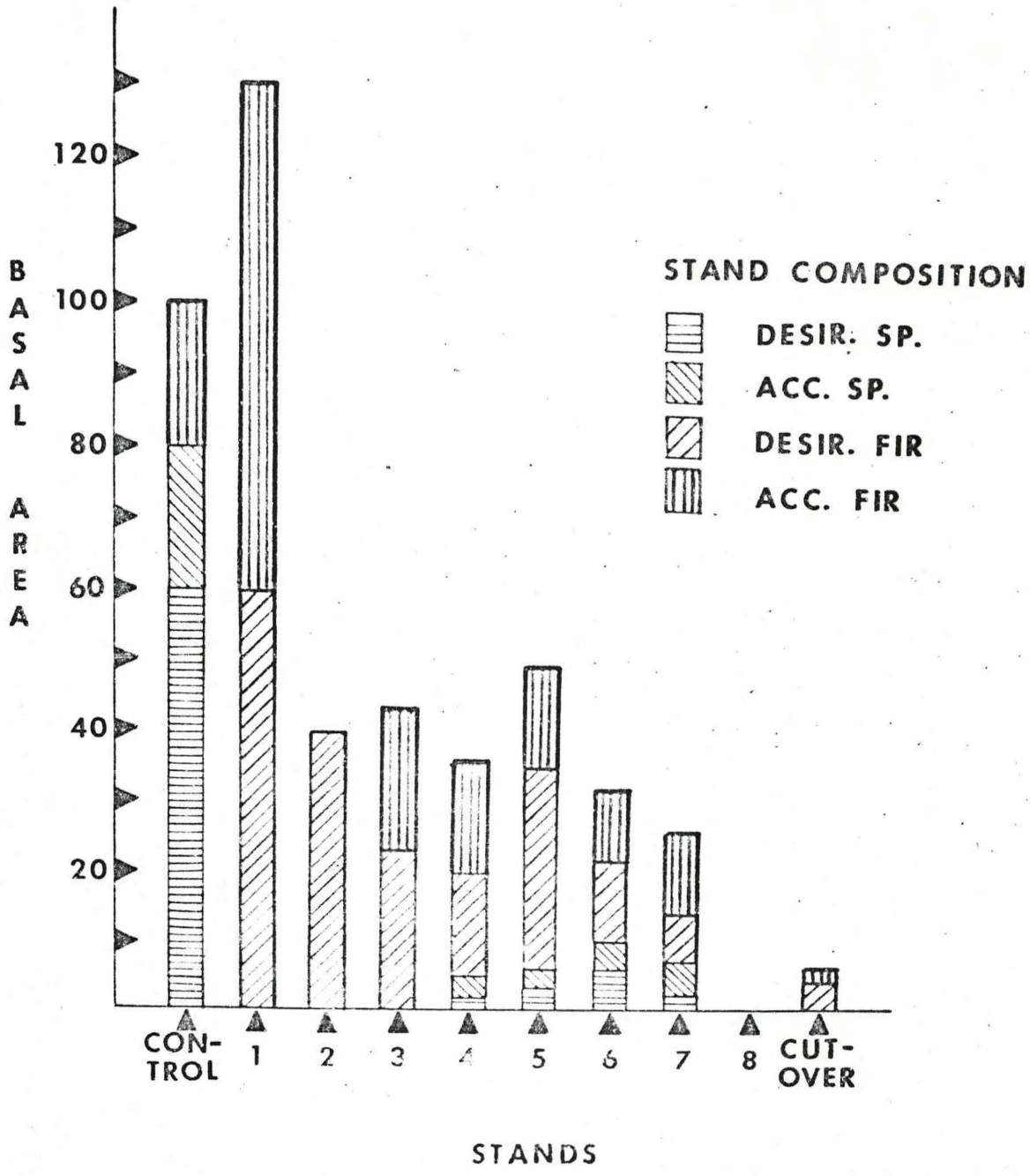


FIGURE 2

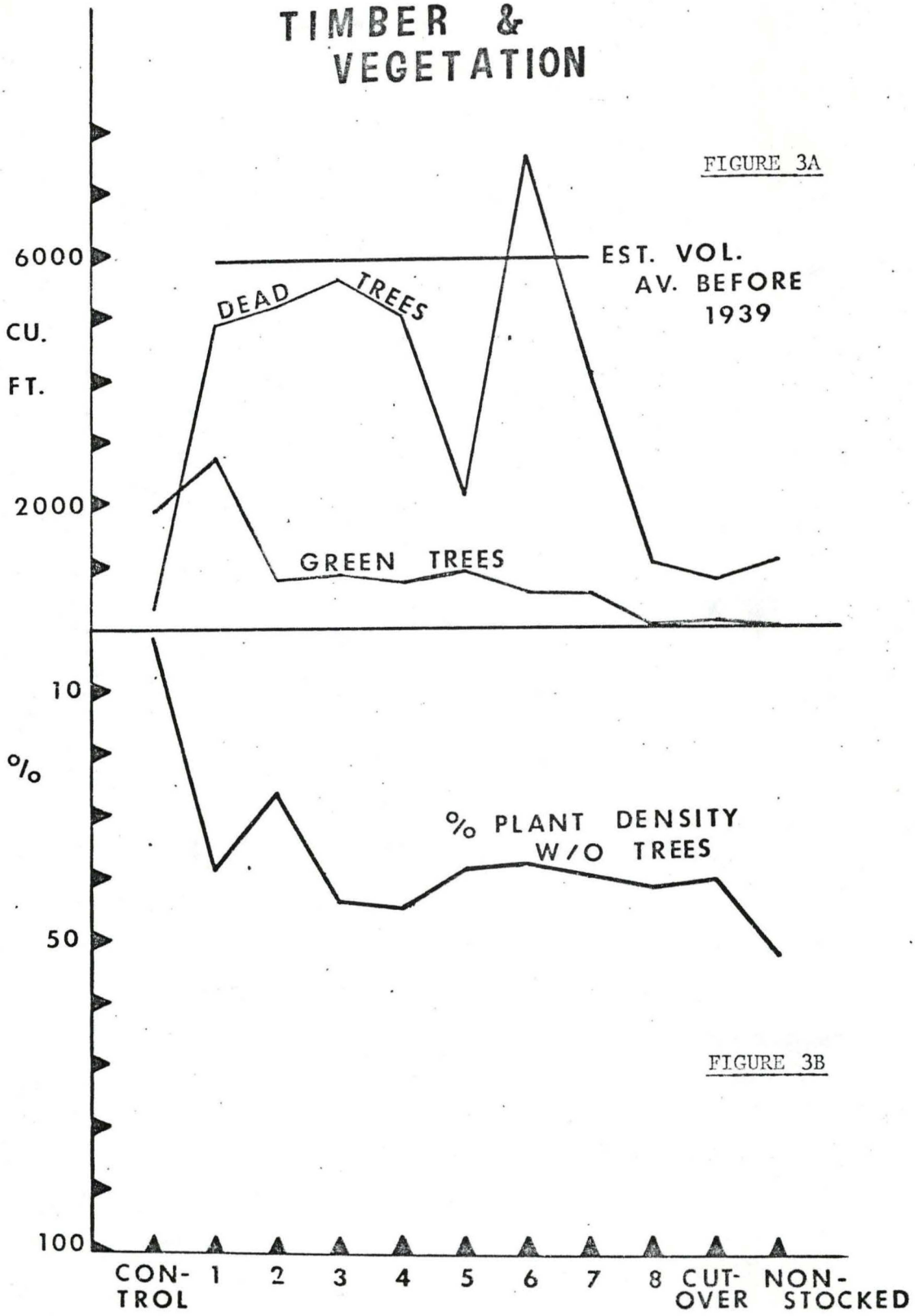


FIGURE 3A

FIGURE 3B

Water

Water yield has benefited from the spruce beetle outbreak, and these benefits will probably continue up to about 50 years from the time the outbreak began. However, this beneficial yield has been decreasing since the outbreak ended (Figure 4) and by about 1990 the White River streamflow will probably return to the 1902-1939 "normal." The White River drainage is only one of four major river drainages which make up the headwaters of the Colorado River, and all were affected by the 1939-1951 spruce beetle outbreak. The Colorado River is the major source of water for most of the Southwest, from the west side of the Rockies to Los Angeles. Some water from the upper drainage has even been diverted to the east side of the Rockies.

The White River drainage has sustained an increased water yield of 218,276 acre feet since the outbreak began in 1941. The Colorado River water values were $5/ac. ft. during the early years of this additional water yield, but some of the present value estimations consider it to be worth $16/ac. ft. Therefore, dollar value of increased yield may be figured: 218,276 @ $5/ac. ft. = $1,091,380; or 218,276 @ $16/ac. ft. = $3,492,416. However, a more realistic dollar value may be $1,438,727, as shown by the following tabulation:

Time period	Acre feet	$/acre	Total value
1941-1964	186,699	$ 5	$ 933,495
1965-1971	31,577	16	505,232
	218,276		$1,438,727

One important consideration in the discussion of water yield is that much water development planning has been done that includes the increased yield created by the spruce beetle outbreak; however, for all practical purposes, this is a temporary situation which may well end by 1990. This becomes more important because present plans call for about half of the White River drainage to be designated as wilderness. On these lands, no stand management will be allowed. Also, there is no present management method (excluding cloud seeding) which can maintain the annual increase of 6,000 acre feet of water on the half of the land that is available outside of wilderness lands since the timber stand will not fully recover from the effects of the beetle outbreak for many more years.

Wildlife

Animal population changes over time were reconstructed by consulting with wildlife specialists. These specialists made observations in the area and used the vegetative data collected on both the control area and the study area as a basis for their estimates (Figure 5).

FIGURE 4.--Increased streamflow during outbreak buildup (1941-46) and epidemic (1947-51), and gradual decrease following outbreak as ground vegetation returns.

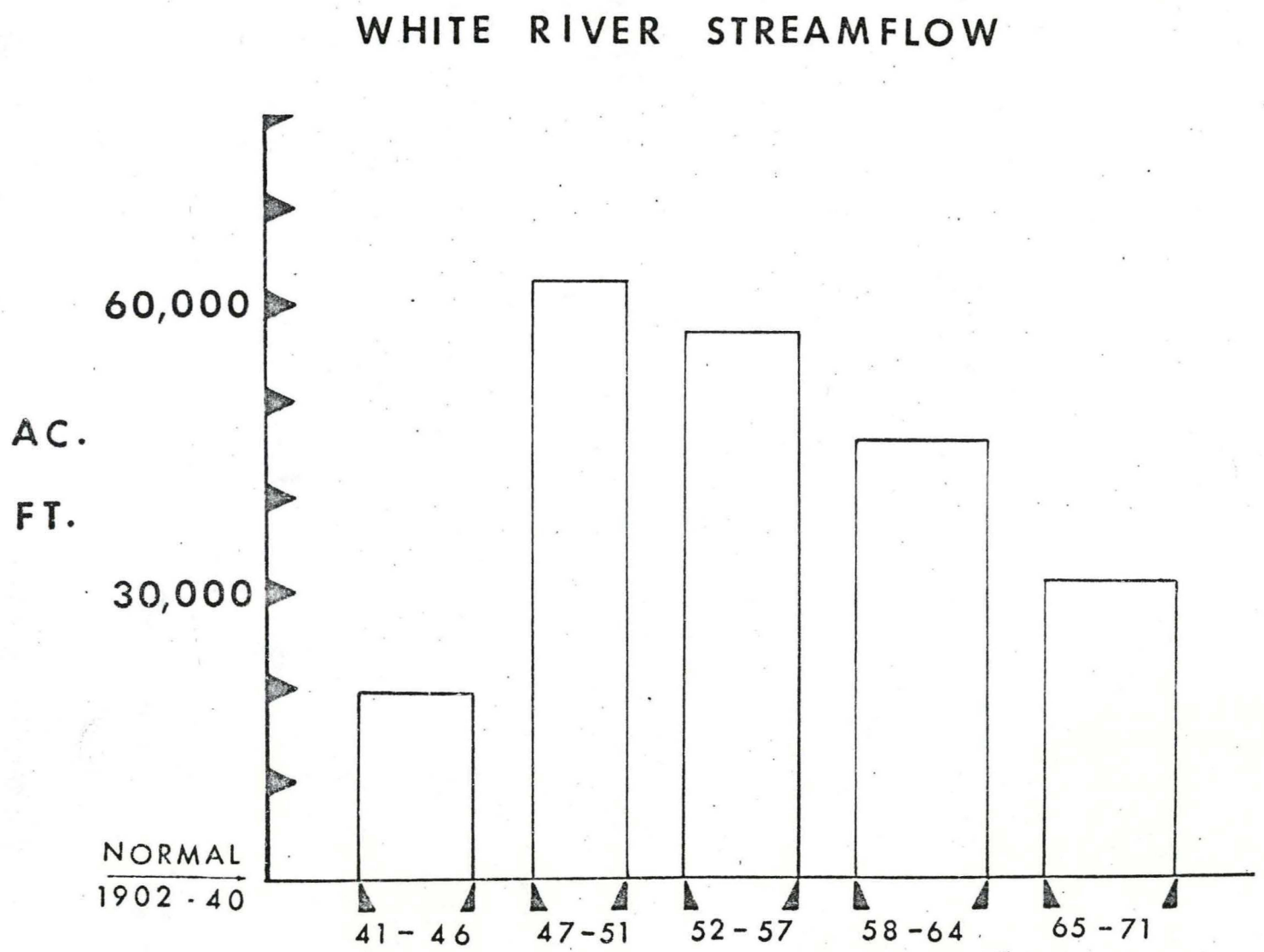
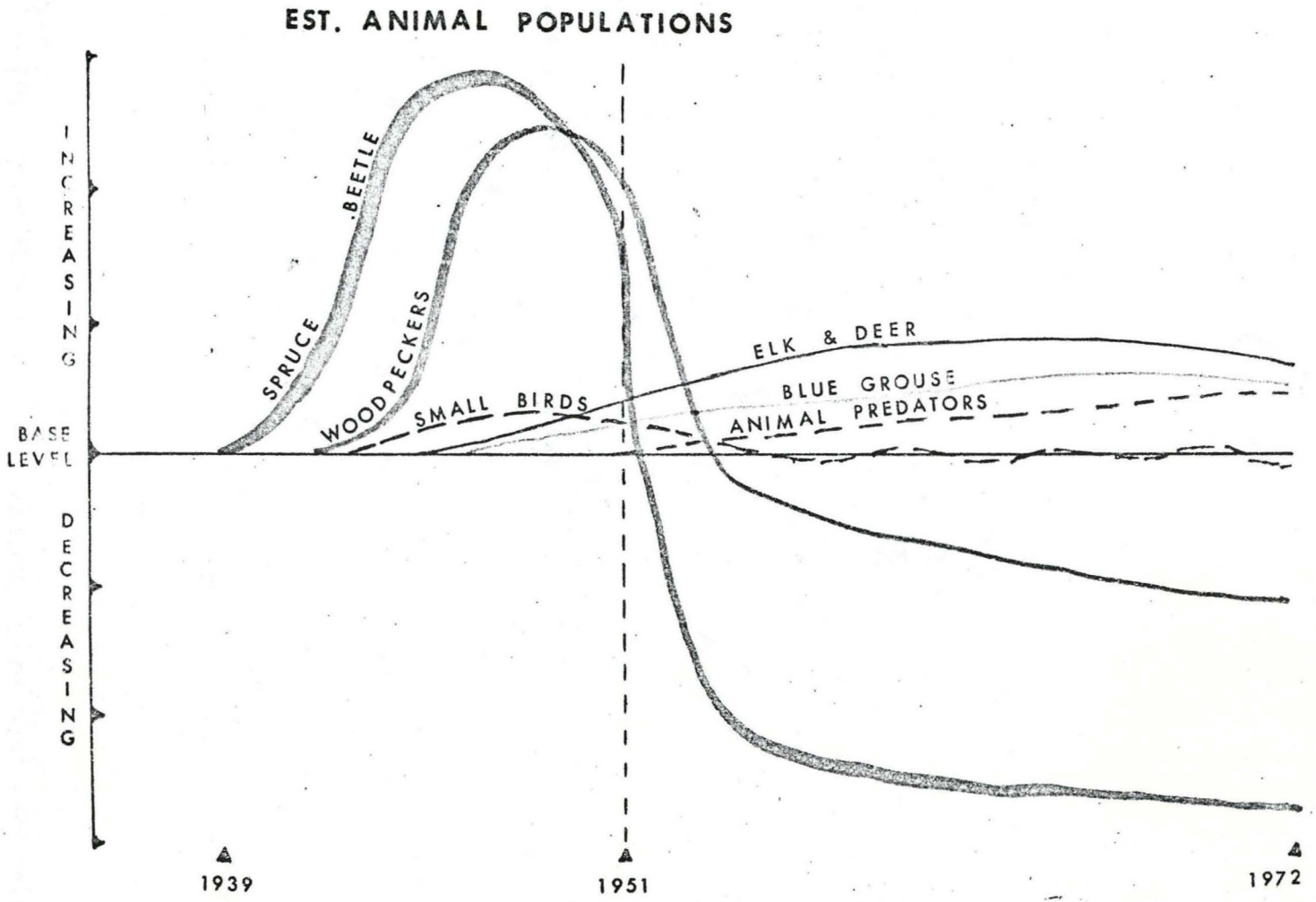


FIGURE 5


EST. ANIMAL POPULATIONS
INCREASING
BASE LEVEL
DECREASING
SPRUCE BEETLE
WOODPECKERS
SMALL BIRDS
ELK & DEER
BLUE GROUSE
ANIMAL PREDATORS
1939
1951
1972

Spruce beetle populations increased rapidly following the 1939 blowdown, reaching a peak in the middle and late 1940's, and then crashing to low levels in 1951. The beetle populations have remained low throughout the study area since that time. These beetle populations had an effect primarily on woodpeckers and small mammals which increased in numbers with the increase in bark beetles. Woodpeckers followed the increase and decline curve of beetle numbers with a more gradual increase at the onset of the epidemic and a decline that was not as drastic as that of the beetles because of secondary insects in the wood. Small mammal numbers increased gradually with the beginning of the epidemic, reached but moderate levels during the epidemic, declined with the end of the epidemic, and have maintained population levels that were about the same as those prior to 1939.

Elk, deer, blue grouse, and large animal predators all increased during the latter stages of the beetle epidemic due primarily to vegetative changes. These animal populations continued a gradual increase for many years with the elk, deer, and grouse populations declining slightly in the last 5 to 10 years. Large animal predators have continued a slight increase to the present time, but may have reached a peak.

Fire

In looking at the spruce beetle impact on the fire situation, we find that it is not too important for about 360 days out of the year. However, for 2 to 8 days of the year, the problem may become very important in protecting the forested environment.

Figure 6 shows that over 40 percent of the forested land in the sample area has 55 or more tons per acre of dead material. Figure 7 shows that 97 percent of the forested area has at least 55 snags/acre and 20 percent of the forested area has 120 snags/acre. In thinking about snags per acre and the tons of dead material, and adding the number of stems of young trees, along with a few days of extreme fire danger rating, we come up with a fire situation that may be difficult to control. In most cases, snag density per acre creates an unsafe situation for the individual firefighter. The risk factor would have to be determined for each stand and resource to be protected.

Man's Maneuverability

What effect has the spruce beetle outbreak had on man's foot travel in forested areas? Man likes to hunt, fish, and backpack into undeveloped areas. Photos 5 and 6 show two similar hillsides. Photo 5 was taken near Deep Lake, and shows a picnic area next to the lake and a campground on a bench above and to the left of the picnic ground. The campground was logged about the time the epidemic was at its peak. Photo 6 was taken on Buck Creek; the area has a similar profile but was not logged. In comparing these two photos, it is easy to see the hazards from snags if the campground had not been logged.

Photo 5.--Deep Lake

Photo 6.--Buck Creek

FIGURE 6

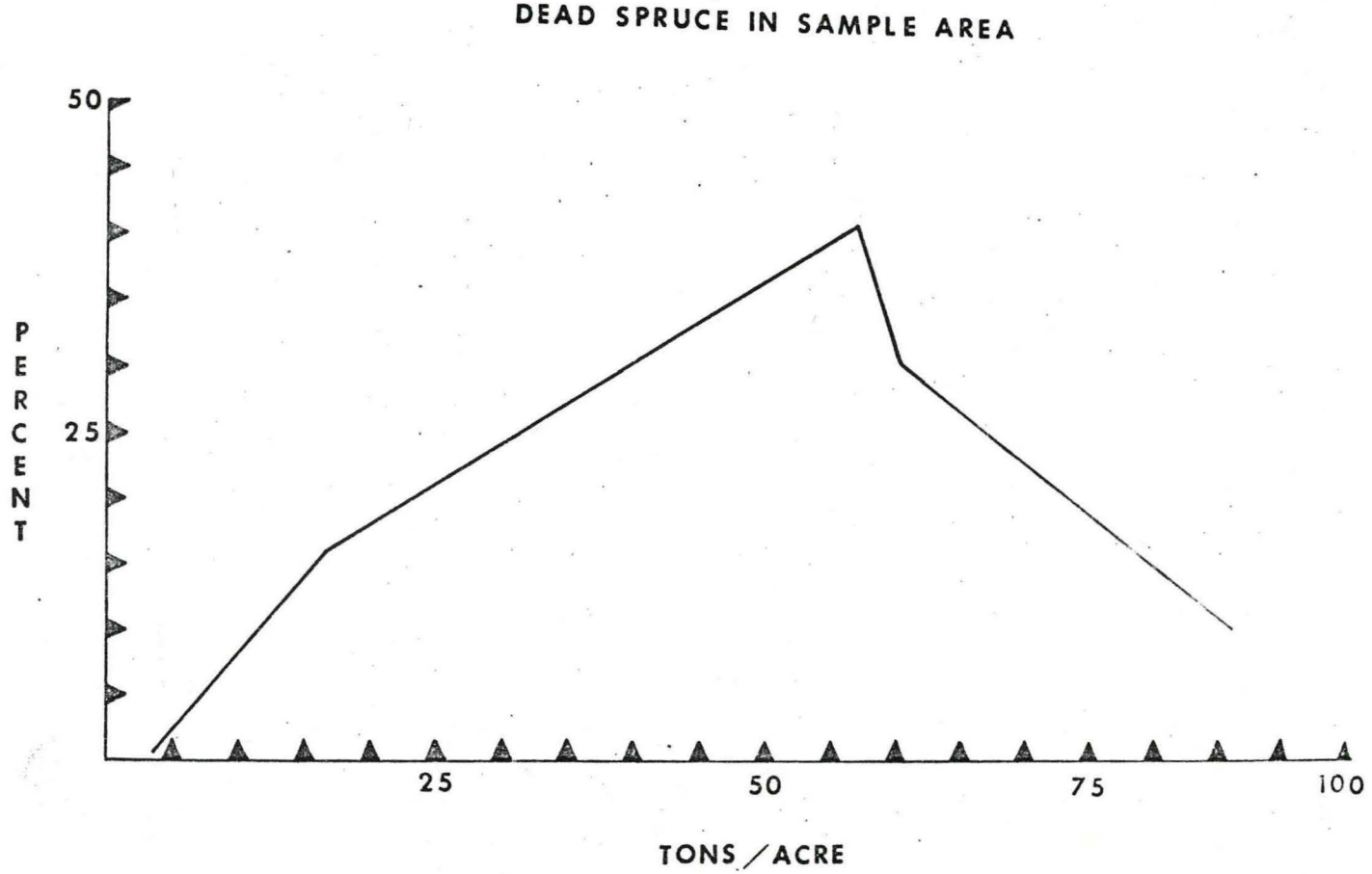
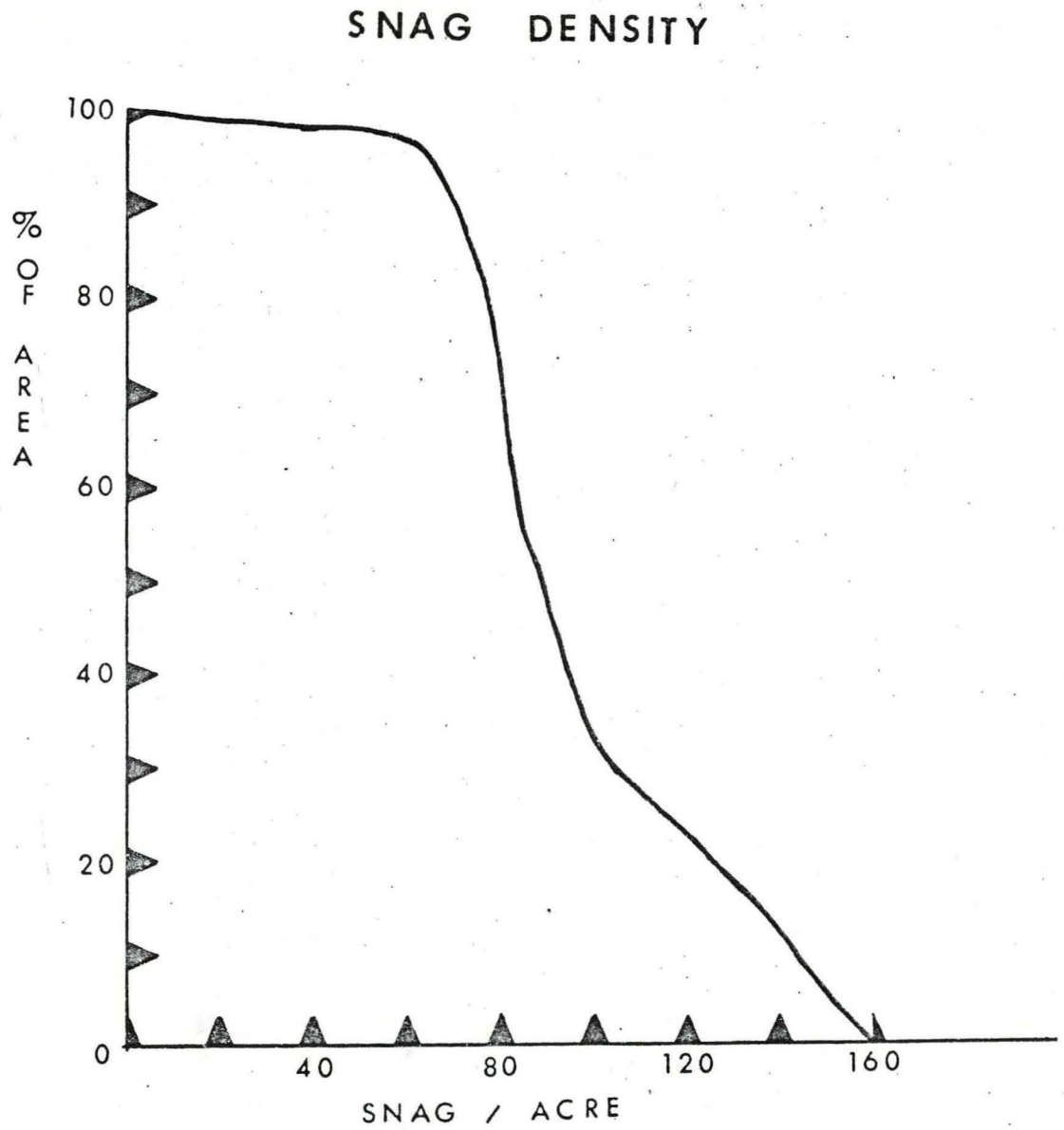

DEAD SPRUCE IN SAMPLE AREA
50
25
PERCENT
25
50
75
100
TONS / ACRE

FIGURE 7



In the study area, stand surveys showed that 41 percent of spruce beetle snags have fallen, of which 28 percent have sap rot. In some areas the down snags have reached a depth of 4 feet per acre. This makes foot travel difficult for both man and big game. Figure 8 shows time studies which were made to determine the difficulty of foot travel at this elevation for a man of average height in fairly good physical condition. It takes twice the time to cover the same distance with 4 feet of down material than when the ground is free of debris. Another hazard to consider in walking in some of these snag patches is that about 2.8 percent of these dead trees fall per year. This hazard increases when there are strong winds and wet soils.

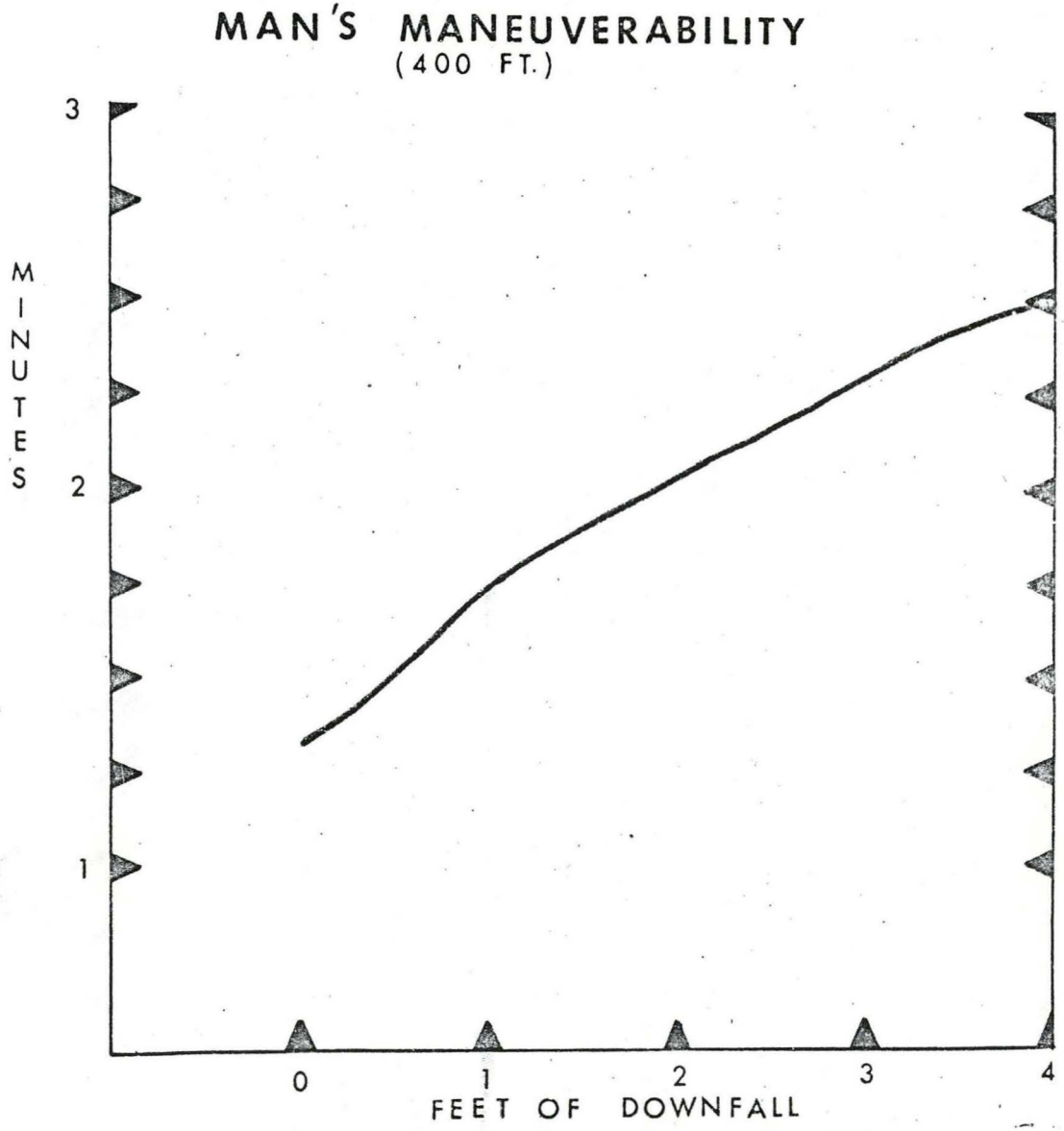
It is estimated that about 20 snags per year will fall across one mile of trail, whereas in most spruce country where spruce beetles have not created a snag problem it would be about 4 or 5 snags per year per mile. Thus the cost of trail maintenance has increased four or five times. As a result, in most spruce beetle snag areas in the White River National Forest, trails have not been cleared (Photos 7 and 8). These snag patches are an added hazard to individuals using these trails. Posting an area is one method used to warn the public of this hazard.

Photo 7.--Standing and down snags along side of an old trail.

Photo 8.--Fallen snags are a continuing problem in trail maintenance in spruce beetle-killed timber on White River National Forest.

Photo 9.--One of the heavy snag patches, showing young reproduction. This stand would be classed DS½Minus.

FIGURE 8


MAN'S MANEUVERABILITY
(400 FT.)
MINUTES
3
2
1
0
1
2
3
4
FEET OF DOWNFALL

A P P E N D I X

INDEX

APPENDIX I

STAND SURVEY COMPUTER PRINTOUT

STAND SURVEY INDEX

The timber stand was subdivided into photo interpretation strata as follows:

Stand no.*	Timber type
1	SF9AWM
2	SF9AWP
3	SF9AMM
4	SF9AMP
5	SF9APP
6	DS½Plus
7	DS½Minus
8	SF8P

*As shown in preliminary report figures.

Explanation of Symbols

SF9AWM
SF = spruce-fir timber type. In this case, most spruce was killed by bark beetles during outbreak.

SF9AWM
9+A = large sawlogs
8 = pole-size trees

SF9AWM
W = well developed crowns
M = medium developed crowns
P = poorly developed crowns

FS9AWM
W = well stocked reproduction
M = medium stocked reproduction
P = poorly stocked reproduction

DS½Plus = all mature spruce are dead; more than one-half of remaining stand composed of green trees (primarily fir).

DS½Minus = all mature spruce are dead; less than one-half of remaining stand composed of green trees.